Photosynthesis of maize and alfalfa during daytime sprinkler irrigation

J. Cavero, Y.F. Urrego, M.V. Fernández, C. Merino, A. Martínez-Cob

Est. Exp. Aula Dei, CSIC, Zaragoza, Spain

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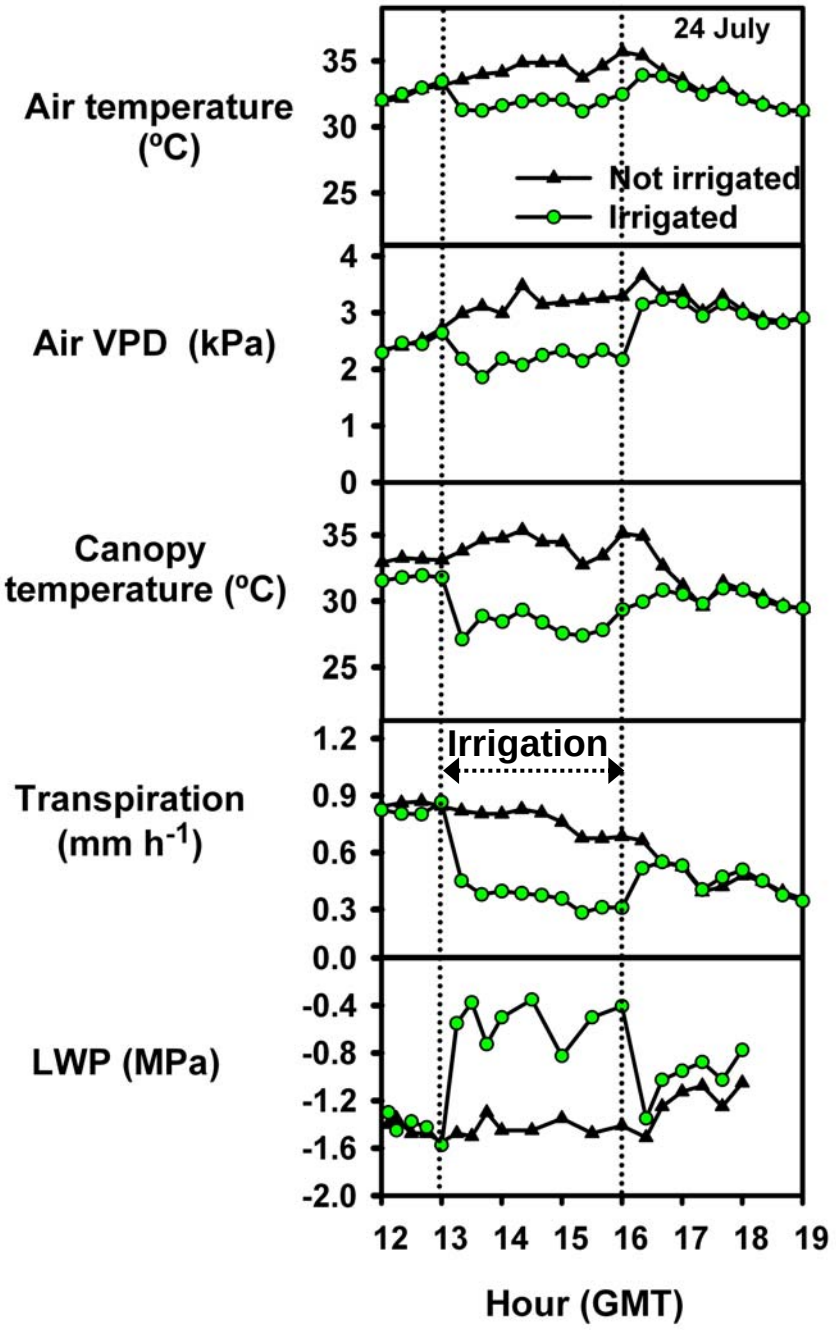
INTRODUCTION

- Some water is lost during a sprinkler irrigation event due to wind drift and evaporation (WDEL) that occurs as water travels from the sprinkler nozzles to the crop, and to evaporation that occurs for water intercepted by stems and leaves after the irrigation event.

- Nighttime sprinkler irrigation usually results in lower WDEL (9%) compared with daytime irrigation (20%).

- Due to WDEL daytime sprinkler irrigation modifies the microclimatic conditions within the crop canopy which could result in improved crop growth.



		CHANGE
Air temperature (ºC)	3.3 – 4.4 ºC	
Air VPD (kPa)	1.0 – 1.2 kPa	
Canopy temperature (ºC)	4.3 – 6.1 ºC	Positive?
Transpiration (mm h^{-1})	58 %	Positive
LWP (MPa)	0.66 – 0.86 MPa	Positive

(Cavero et al., 2009)

OBJECTIVE

- To quantify how photosynthesis is affected by daytime sprinkler irrigation in two field crops: maize (*Zea mays* L.) and alfalfa (*Medicago sativa* L.).

GENERAL CHARACTERISTICS

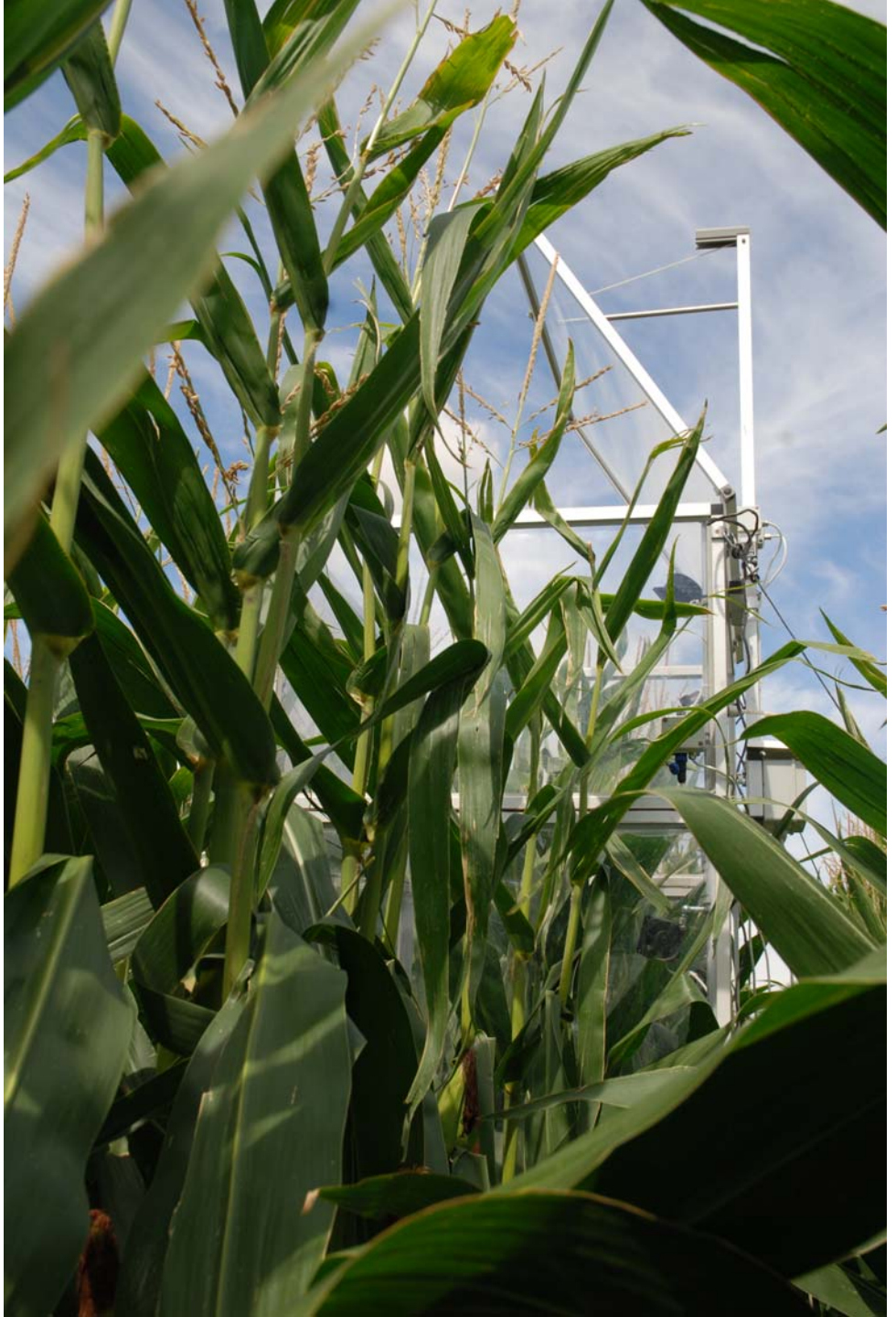
- ✓ Two experiments: one for maize and another for alfalfa.
- ✓ Maize
  - ➢ Cultivar: Pioneer PR34N43.
  - ➢ Sowing date: April 2009.
  - ➢ Plant density: 85,000 plants ha^{-1}; rows, 0.75 m.
- ✓ Alfalfa
  - ➢ Cultivar: Aragon
  - ➢ Crop year: 2nd.
- ✓ Crop water requirements, weekly. $ET_c = Kc \times ET_0$.
  - ET_0, standard weather station over grass (FAO PM).
  - Kc, crop coefficient.
- ✓ Irrigation applied= $(ET_c - P_{eff})$ + WDEL
  - P_{eff}, effective precipitation.

MEASUREMENTS

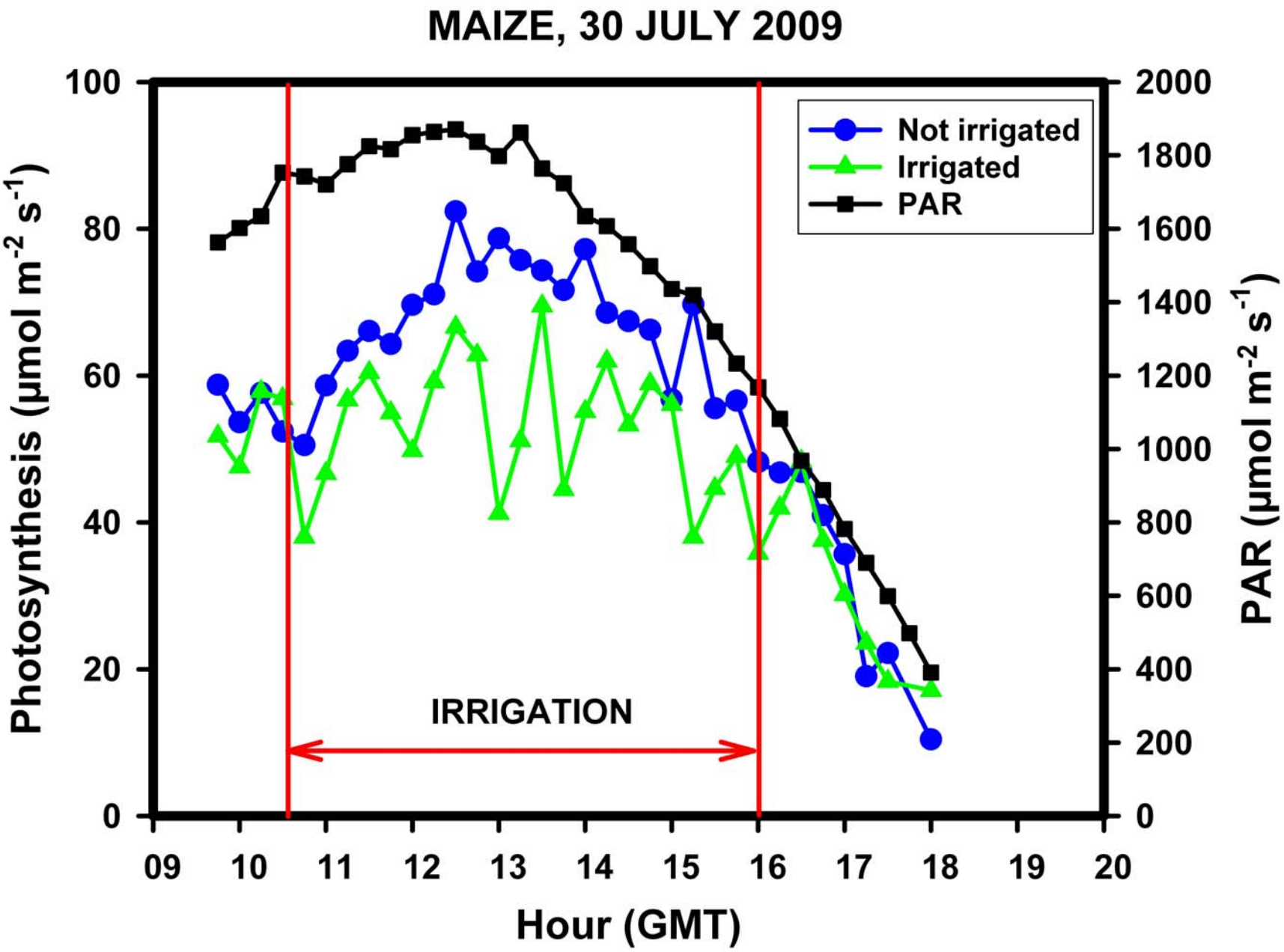
- ✓ Net photosynthesis since one hour before irrigation started until two hours after irrigation finished measured in the irrigated and the non irrigated plots.

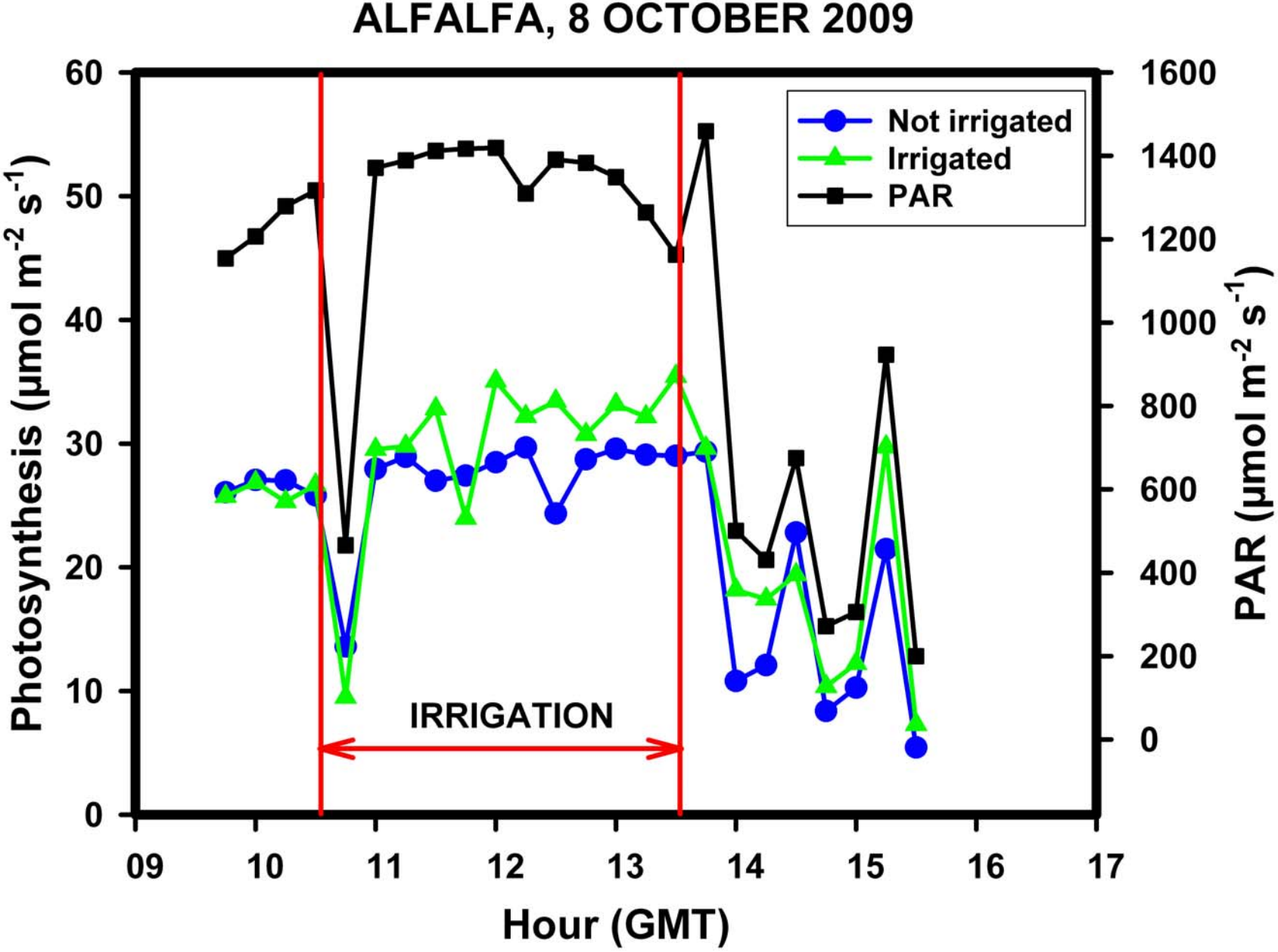
- ✓ Canopy chamber:
  - ➢ Area:0.75m x 1.0m.
  - ➢ Height: 0.58m (alfalfa); 2.50m (maize)
  - ➢ Automatically close every 15 min during 50 s.
- ✓ Air CO_2 measured with an IRGA (LI-7000).
- ✓ Two canopy chamber-IRGA units.
- ✓ Measurement of internal temperature with a thermocouple.

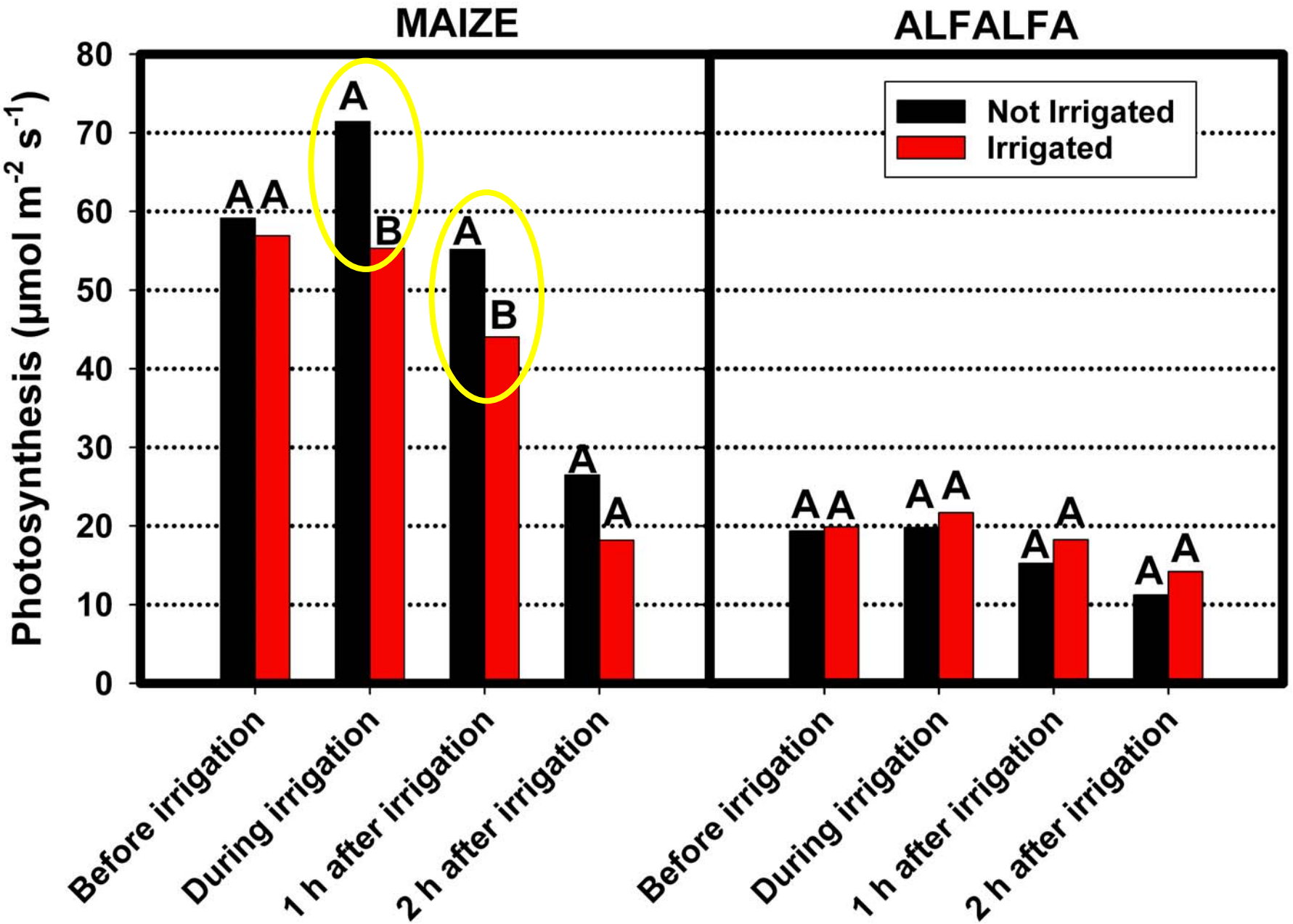
- ✓ Five measurement days for each crop.



RESULTS


MAIZE, 30 JULY 2009
Not irrigated
Irrigated
PAR
IRRIGATION
Photosynthesis (µmol m-2 s-1)
PAR (µmol m-2 s-1)
Hour (GMT)
0
20
40
60
80
100
0
200
400
600
800
1000
1200
1400
1600
1800
2000
09
10
11
12
13
14
15
16
17
18
19
20


ALFALFA, 8 OCTOBER 2009
Not irrigated
Irrigated
PAR
IRRIGATION
Photosynthesis (µmol m-2 s-1)
PAR (µmol m-2 s-1)
Hour (GMT)
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400
1600
09
10
11
12
13
14
15
16
17


MAIZE
ALFALFA
Not Irrigated
Irrigated
Photosynthesis (µmol m-2 s-1)
80
70
60
50
40
30
20
10
0
A A
A
B
A
B
A
A
A A
A A
A
A
A
Before irrigation
During irrigation
1 h after irrigation
2 h after irrigation
Before irrigation
During irrigation
1 h after irrigation
2 h after irrigation

Maize leaf
Contact angle:
Adaxial= 68º
Abaxial= 52º

Wettable leaf

Alfalfa leaf
Contact angle:
Adaxial = 122º
Abaxial = 113º

Non wettable leaf

CONCLUSIONS

- ✓ The rate of photosynthesis of maize was significantly reduced by 23% during the sprinkler irrigation event and by 20% during the following first hour.
- ✓ The rate of photosynthesis of alfalfa was slightly increased (not significantly) during the sprinkler irrigation event and during the following first hour.
- ✓ The reduction of maize photosynthetic rate during sprinkler irrigation was related with the high wettability of the leaves that reduced the CO_2 uptake.
- ✓ The low wettability of alfalfa leaves precluded any reduction of CO_2 uptake due to sprinkler irrigation.
- ✓ Daytime sprinkler irrigation of maize should be avoided.